Values of some astronomical constants proposed for NSFA

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We propose to the NSFA WG (the IAU Working Group on Numerical Standards for Astronomy) the following representative values and realistic uncertainties for the masses of the three largest asteroids, to be used as the current best estimates:

$$M_{Ceres}/M_\odot = \mathbf{4.72(3)}\cdot 10^{-10},$$
$$M_{Pallas}/M_\odot = \mathbf{1.03(2)}\cdot 10^{-10},$$
$$M_{Vesta}/M_\odot = \mathbf{1.35(2)}\cdot 10^{-10}.$$

Unlike the values previously adopted in Astromnomical Almanac, these are consistent with nearly all of the twenty or so modern accurate determinations from various authors. We also propose the following values obtained from the DE, EPM ephemeris improvement processes: $M_{Moon}/M_{Earth} = 0.1023000371(4)$ and AU = 149597870700(3) m. The same AU value in m is TDB- and TCB-compatible for the version of conversion between TDB and TCB proposed by Fukushima, Brumberg and Simon.

Masses of Ceres, Pallas and Vesta in $10^{-10} M_\odot$)

Ceres	Pallas	Vesta	Year	Authors
5.0 ± 0.2	1.4± 0.2	1.5 ± 0.3	1989	Standish & H
4.796 ± 0.085			1992	Sitarski & To
4.62 ± 0.07		1.396 ± 0.043	1995	Sitarski & To
4.64	1.05	1.34	1995	Standish et a
4.35 ± 0.05	1.60 ± 0.04	1.52 ± 0.09	1997	Hilton
4.759 ± 0.023			1998	Viateau & Ra
4.70	1.00	1.30	1998	Standish
4.39 ± 0.04	1.59 ± 0.05	1.69 ± 0.11	1999	Hilton
4.70 ± 0.04	1.21 ± 0.26	1.36 ± 0.05	2000	Michalak
	1.17 ± 0.03		2001	Goffin
		1.306 ± 0.016	2001	Viateau & Ra
4.76 ± 0.02	1.08 ± 0.04	1.35 ± 0.02	2000	Standish
4.81 ± 0.01	1.00 ± 0.01	1.36 ± 0.01	2001	Pitjeva
4.69 ± 0.01	1.05 ± 0.01	1.36 ± 0.01	2003	Standish
4.753 ± 0.007	1.027 ± 0.003	1.344 ± 0.001	2005	Pitjeva
4.699 ± 0.028	1.026 ± 0.028	1.358 ± 0.016	2006	Konopliv et a
4.736 ± 0.026			2007	Kovacevic&K
4.75 ± 0.03	1.06 ± 0.13	1.34 ± 0.01	2008	Baer & Chesl
4.746 ± 0.006	0.995 ± 0.003	1.338 ± 0.002	2008	Fienga et al.
4.685	1.010	1.328	2008	Folkner et al.
4.712 ± 0.006	1.027 ± 0.007	1.344 ± 0.003	2008	Pitjeva

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The Earth-Moon Mass Ratio

DE414 (Standish, 2006):

$$M_{Earth}/M_{Moon} = 81.3005678.$$

DE421 ephemeris (Folkner et al., 2008):

$$M_{Earth}/M_{Moon} = 81.3005691 \pm 0.0000005$$

EPM2008 (Pitjeva, 2008):

$$M_{Earth}/M_{Moon} = 81.3005690 \pm 0.0000001$$

We have proposed the following value of the ratio of the masses of the Earth and the Moon:

$$M_{Earth}/M_{Moon} = 81.300569 \pm 0.000003$$

or the ratio of the masses: of the Moon and the Earth, as it is customary the NSFA

$$M_{Moon}/M_{Earth} = 0.0123000369(4).$$

The Value of Astronomical Unit in km

ephemerides	AU-149597870	ephemerides	AU-149597870	real uncertainty
DE200	0.66±0.03	EPM87	0.62±0.18	0.2
DE405	0.6916±0.0005	EPM2000	0.6912±0.0002	0.01
DE414	0.7008±0.00015	EPM2006	0.6953±0.0001	0.005
DE421	0.6996±0.00015	EPM2008	0.6954±0.0001	0.003

We propose for the NSFA WG the value AU:

$$AU = 149597870700(3)m$$

which is consistent with the value GM_{Sun}:

$$GM_{Sun} = 1.32712442099(10) \cdot 10^{20}[m^3/s^2]$$

proposed to NSFA WG by W.Folkner.

The value GM_{Sun} in the physical system of units $[m^3/s^2]$ may be estimated from fitting ephemerides to observations. However, up to present this value has been calculated from the adjusted AU value, obtained in meters while fitting planet ephemerides, as

$$GM_{Sun}[m^3/sec^2] = k^2\ AU[m]^3/86400[s]^2.$$

All of the main ephemerides of JPL and IPA have been constructed in the TDB time scale, and the AU value proposed to NSFA has been obtained from DE414, DE421 built in the TDB time scale also. For the version of conversion between TDB and TCB proposed by Fukushima, Brumberg and Groten (2001), Brumberg and Simon (2003), the AU in meters has the same numerical value for ephemerides built in the TDB and TCB time scale.

Two versions of the IPA ephemerides were constructed in 2002, one in the TDB time system and the other in the TCB system, in accordance with this conversion (Pitjeva, 2003). These ephemerides were fitted to data (1913–2002); all the rms residuals were identical, and the same AU value was obtained for both of these ephemerides, as expected.